CORDIC

Introduction to digital Low-Level Radio Frequency Controls in Accelerators

Lab 5

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1 Introduction

This lab will guide you through the CORDIC (COordinate Rotation DIgital Computer) introduced in the lecture. Much of the code is derived from Berkeley Lab's `bedrock/cordic` repository.

We use Berkeley Lab's cordic module for the following lab.

The unit under test is `cordicg_b22.v`, which is generated by `cordicgx.py` with 22 bits internal data path width.

Input data width of `xin`, `yin` is configurable as a parameter of testbench, defined by `DW` in `Makefile`. The number of stages `NSTG` is also an parameter of the test bench.

We will test both Polar to Rectangular, and Rectangular to Polar conversion.

Use `make` to build test bench, run simulation and print results for analysis. Details check `Makefile`

2 Exercises

2.1 Polar to Rectangular

To get an ordinary P->R set `yin` to zero. It's also possible to use that mode for general vector rotation of the input `(xin, yin)` vector by angle `phasein`, which is the case using the test bench.

Note that the CORDIC propagation delay of `NSTG` cycles are already taken care of, so that the printed data is an aligned row of `"T [ns]", "phasein", "xin", "yin", "xout", "yout", "phaseout"` at every clock cycle .

Pay attention to the full scale of `phasein` and `phaseout` ports, which has `DW+1` data width. The full scale of these two signals are $[0, 2\pi]$.

Check the CORDIC accuracy by comparing the expected vector after rotation and its output `(xout, yout)` for all data. What's the peak to peak and RMS error percentage?

2.2 Rectangular to Polar

To get an ordinary R->P computation set `phasein` to zero. A non-zero `phasein` in that mode will simply be added to the answer.

The test bench will work in the prior case. Check the CORDIC accuracy by comparing the expected amplitude and angle of `(xin, yin)` and the CORDIC output `xout`, `phaseout` respectively. What's the peak to peak and RMS error percentage?

2.3 Change data width and observe the difference

2.4 Change number of stages and observe the difference